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A Lower Bound: Why the Social Cost of Carbon Does Not Capture Critical Climate Damages and What That Means for Policymakers

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The social cost of carbon (SCC) developed by the Obama-era Interagency Working Group (IWG) is currently the best available estimate for the damages done by each additional ton of greenhouse gas emissions, and this tool has been used by many federal and state policymakers to evaluate and craft climate-related policies.[1] However, the SCC does not account for many of the severe consequences of climate change identified by the Intergovernmental Panel on Climate Change (IPCC).[2] This means that we should treat the most recent (2016) IWG SCC estimates, such as the "central" estimate of about $51 per ton of carbon dioxide,[3] as a lower bound when we monetize climate damages to assess policies that affect greenhouse gas emissions.[4]

Introduction

Under the Obama administration, the U.S. government convened a group of experts from several federal agencies to develop a range of monetary values that captures the expected damages of greenhouse gas pollution. Their work from 2010 through 2016 delivered estimates that were based on the best available science and economics.[5] While these SCC estimates include a number of categories of expected climate damages, they are partially missing the costs of extreme weather and other climate damages that the IPCC emphasizes in its latest state-of-the-climate report, the Fifth Assessment Report (AR5).[6] Set at around $51 per ton of carbon dioxide emissions, the "central"[7] SCC estimate

Photo © Bureau of Land Management Oregon and Washington developed by the Obama-era Interagency Working Group on the Social Cost of Greenhouse Gases (IWG), has been used to make decisions about greenhouse gas pollution standards and other policies.[8] The SCC helps gauge whether the benefits of controlling carbon emissions outweigh the costs of limiting pollution. But because SCC estimates omit the costs of so many expected damages, the pollution limits policymakers set are often less stringent than they should be.

What the IPCC Predicts

The IPCC, made up of almost 200 renowned scientists from around the world, is tasked with assessing the latest peer-reviewed information on climate change in order to provide governments with policy guidance. The last assessment report from the IPCC, AR5, was released in 2014. AR5 highlights many advancements in our understanding of climate science, including the nature and magnitude of risks and impacts associated with climate change (the previous assessment report was released in 2007).[9] Covering 12,000 peer reviewed scientific and economic research articles, AR5 emphasizes that, while average temperature increases are important, it is extreme weather and broad economic, public health, and ecosystem changes that are particularly damaging, and particularly costly.[10]

In 2018, the IPCC also released a special report on keeping warming below 1.5 degrees Celsius.[11] The 2018 special report tells us that we could reach 1.5 degrees of warming as soon as 2030; in this scenario, the world will likely experience many of these disruptive or catastrophic consequences of climate change sooner than previously thought. This is complicated by the fact that the United States and other countries around the world have not taken adequate steps to reduce emissions in order to limit warming below 2 degrees Celsius, much less below 1.5 degrees. Moreover, the models used by the IWG may not account for the potential of an accelerated timeline. This leaves Americans extremely vulnerable.

Why It Matters

The SCC has been used in a number of important decisionmaking contexts.[12] While the IWG SCC was developed for use in federal regulatory analysis, it has also been featured in analysis for projects on federal lands and used by states for electricity regulation and climate policy.

The economic models that underlie the IWG's SCC estimate, known as integrated assessment models (IAMs), were the most up-to-date tools available during the IWG's work.[13] But these models only partially account for, or omit altogether, many significant impacts of climate change, including many which the IPCC stressed were very destructive. (Our 2014 report, *Omitted Damages*, explains in detail what the IAMs are missing and how it affects the IWG estimates.)[14]

A number of climate impacts are difficult to quantify or monetize, and models of these effects need further development; therefore, many significant damages are not fully included in the IAMs.[15] The IWG SCC estimates are based on models that place no value on some major climate impacts like increased fire risk, the geographic spread of pests and pathogens, slower economic growth, mass extinctions, large-scale migration, increased social and political conflict, violence borne of resource scarcity, and the loss of coral reefs and other aquatic life. This implies that society would not pay a penny to avoid sticking the next generation with these phenomena. These omissions result in a very significant underestimate of the IWG SCC.[16]

The IAMs do a good job of measuring the direct costs of average temperature increases, but a poor job of capturing other critical climatic and ecosystem changes that could lead to very large economic losses. Specifically, the IAMs struggle to capture the interactions between large ecosystem and climate changes - or "impact drivers" as the IPCC calls them. For example, the IPCC projects both higher seas and more frequent hurricanes, both of which are included in the economic models. But when combined, these changes lead to more significant storm surges, and the potentially large damages from this interaction is omitted. And because the IAMs are entirely missing many other key ecosystem and climate changes identified by the IPCC, the IWG cost estimates that rely on these models are missing them too.[17]

The IAMs also fail to account for other variables discussed in AR5, such as the role of social factors in projecting climate impacts. For example, income inequality, political representation, and prevalence of violence will all affect the nature of climate damages. Additionally, non-climate stressors, such as over-pumping of groundwater, are important determinants of the magnitude of climate impacts, and the models do not address these pressures adequately (and in some cases, not at all).[18]

In addition, the IWG SCC estimates are skewed downward because of the way the IAMs take into account the costs of adaptation. Each IAM treats adaptation differently: one model implicitly takes into account how adaptation may reduce climate damages; another takes into account some forms of adaptation, such as seawalls; the final model explicitly includes adaptation costs for all non-catastrophic impacts.[19] A number of scholars consider the IAMs too optimistic about the ability of adaptation to reduce climate damages.[20] Given these factors and the potentially condensed timeline to adapt to climate impacts, the SCC estimate may be biased downward even further.[21]

The tables below summarize the damages highlighted by the IPCC in AR5 compared to what is included in the IWG SCC estimates.

How We Should Proceed

These omitted factors in the IWG SCC should motivate policymakers to use the estimates that are most appropriate for their jurisdiction's circumstances, knowing that there is little chance that they are weighing the costs of climate change too heavily if they use a figure based on the IWG SCC.

Some decisionmakers have already taken actions that reflect the conservative nature of the IWG SCC. For example, states like Washington and California have begun to consider using higher values from the IWG's range of estimates.[22] Policies reflecting these choices will account for more severe expected climate damages, compared to the central SCC estimate.[23] Given that the IWG SCC should be considered a lower bound, many policymakers may push further in this direction when trying to account for the full effects of climate change.

Future improvements to the SCC calculation may provide a more appropriate range of estimates. In recent reports,[24] the National Academy of Sciences highlighted extensive damage literature currently ignored by IAMs. Economists and scientists need to work together to synthesize this literature and other findings into the IAMs to improve damage estimates, particularly by filling in missing gaps in the climate impact literature identified by the IPCC. Groups tasked with updating the SCC can use these reports as guidance. Some groups are doing just this, including Resources for the Future[25] and the Climate Impact Lab.[26] Finally, groups working on updating the SCC should continue to address new information as it becomes available, so that the SCC better represents the full extent of expected climate impacts.

Table 1: How the IWG SCC Accounts for IPCC Climate Impact Drivers

Status	Climate-Related Drivers of Impacts
Excluded	Extreme temperature *The health impacts of extreme temperatures are the only impact considered by IAMs*
	Drying trend
	Extreme precipitation
	Snow cover
	Ocean acidification
Partially Included	Flooding *Coastal flooding is included and inland flooding is excluded*
	Storm surge *Partially included, but the models fail to account for the combined effect of sea level rise and increased intensity of coastal storms*
Included	Warming trend
	Precipitation
	Damaging cyclones
	Carbon dioxide concentration
	Sea level rise

Table 2: IPCC Climate Impacts in the IWG SCC Estimates

Damage Type	Sector	Status	Impact
Economic	Agriculture	Included	Impacts on average crop yields due to average temperature increases and CO_2 fertilization effect *Models are more optimistic than current observations, potentially due to optimistic assumptions about CO_2 fertilization effect*
		Excluded	Increases in yield variability
		Excluded	Change in food quality, including nutrition content
		Excluded	Increased pest and disease damage
		Excluded	Flood and sea level impacts on food infrastructure and farmland
		Excluded	Food security
		Excluded	Food price stability and price spikes
	Forestry	Included	CO_2 fertilization
		Included	Shifting geographic range
		Excluded	Increased pest and disease damage
		Excluded	Increasing risk of wildfire
	Fresh water availability	Included	Changing precipitation
		Excluded	Melting snowpack
		Excluded	Changing water quality
		Excluded	Competing uses, including overexploitation of groundwater resources
		Excluded	Water security and water prices
		Partially Included	Water supply system losses and disruptions *While general infrastructure costs of coastal extreme events (flooding and storms) are included, inland extreme events are omitted. Also, IAMs exclude more long-term costs from these infrastructure losses, including human suffering.*
	Fisheries and aquatic tourism	Excluded	Shifted geographic ranges, seasonal activities, migration patterns, abundances, and species interactions
		Excluded	Reduced growth and survival of shellfish and other calcifiers
		Excluded	Coral bleaching
		Excluded	Decrease in catch potential at some latitudes

Damage Type	Sector	Status	Impact
Economic *continued*	Energy	Partially Included	Energy system losses and disruptions *While general infrastructure costs of coastal extreme events (flooding and storms) are included, inland extreme events are omitted. Also, IAMs exclude more long-term costs from these infrastructure losses, including human suffering and increases in energy prices.*
	Property and infrastructure loss	Included	Coastal property losses due to storms, flooding, and sea level rise
		Excluded	Inland property loss due to extreme weather events, including flooding
		Excluded	Melting permafrost
		Excluded	Wildfires
	Declining economic growth	Excluded	Labor productivity
		Excluded	Prolonging and creating new types of poverty traps
		Excluded	Diverted R&D funds for adaptation research
		Excluded	Lost land, capital, and infrastructure
Non-market	Human health *Cardiovascular, respiratory disorders, diarrhea, and morbidity for some health impacts are included in FUND, and thus partially included in PAGE*	Included	Coastal mortality from flooding and storms
		Included	Spread in geographic range of vector-borne diseases *Significant diseases are included, though Lyme disease is excluded*
		Excluded	Wildfires
		Excluded	Mortality from inland extreme weather events
		Excluded	Food and water availability
		Partially Included	Heat related deaths
		Partially Included	Water-borne diseases
		Partially Included	Morbidity: non-fatal illness and injury
		Partially Included	Air quality *Air quality is included in DICE, though it does not account for changes due to pollen or wildfire*
	Terrestrial, freshwater, and marine ecosystems and wildlife	Included	Shifted geographic ranges, seasonal activities, migration patterns, abundances, and species interactions *The value of ecosystems and biodiversity are included in general terms, not specific to any one damage*
		Included	Extinction and biodiversity loss
		Excluded	Non-climate stressors: habitat modification, over-exploitation, pollution, and invasive species

Damage Type	Sector	Status	Impact
Non-market *continued*	Terrestrial, freshwater, and marine ecosystems and wildlife *continued*	Excluded	Abrupt and irreversible regional-scale change in the composition, structure, and function of ecosystems *Environmental tipping points in non-climate systems are excluded*
		Excluded	Effects of ocean acidification on polar ecosystems and coral reefs *Ocean acidification is excluded*
		Partially Included	Loss of habitat to sea level rise *Wetland loss explicitly modeled in FUND, and thus partially in PAGE*
Social	Migration	Excluded	Increased displacement *FUND partially accounts for migration, but uses arbitrary measurements of resettlement and costs*
	Social and political instability	Excluded	Violence, civil war, and inter-group conflict
		Excluded	National Security
Non-climate stressors	Non-climate stressors	Excluded	Climate-related hazards exacerbate other stressors
	Multidimensional inequalities	Excluded	Inequalities, including income
	Violent conflict	Excluded	Violent conflict increases vulnerability
Tipping points	Climate tipping points *Known tipping points are modeled as a single event, instead of multiple events. Furthermore, fat tails, which capture unknown tipping points, are excluded*	Partially Included	Reduction in terrestrial carbon sink
		Partially Included	Boreal tipping point
		Partially Included	Amazon tipping point
		Partially Included	Other tipping points
	Ecosystem tipping points	Excluded	Abrupt and irreversible regional-scale change in the composition, structure, and function of ecosystems *Environmental tipping points in non-climate systems are excluded*

Endnotes

1 Iliana Paul et al. Institute for Policy Integrity, The Social Cost of Greenhouse Gases and State Policy (2017), *available at*: https://policyintegrity.org/publications/detail/social-cost-of-ghgs-and-state-policy. [Hereinafter Policy Integrity 2017].

2 Peter Howard, Cost of Carbon Project. Omitted Damages: What's Missing from the Social Cost of Carbon (2014), *available at*: http://costofcarbon.org/reports/entry/omitted-damages-whats-missing-from-the-social-cost-of-carbon [hereinafter "Omitted Damages"]. "Playing Catch Up to the IPCC," CostOfCarbon.org (Apr. 22, 2014).

3 For 2020 emissions in 2018 dollars; Interagency Working Grp. on Soc. Cost of Greenhouse Gases, Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12,866, at 4 (2016) [hereinafter 2016 TSD] *available at* https://www.obamawhitehouse.gov/sites/default/files/omb/inforeg/scc_tsd_final_clean_8_26_16.pdf.

4 For more on why the IWG SCC should be considered a lower bound, see Richard L. Revesz et al., *Global Warming: Improve Economic Models of Climate Change*, 508 Nature 173 (2014).

5 Interagency Working Grp. on Soc. Cost of Greenhouse Gases, Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12,866 (2010) [hereinafter 2010 TSD] at 5, *available at* https://obamawhitehouse.archives.gov/sites/default/files/omb/inforeg/for-agencies/Social-Cost-of-Carbon-for-RIA.pdf.

6 IPCC: *IPCC Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (2014) [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp. [Hereinafter AR5].

7 See Policy Integrity 2017, *supra* note 1. (The IWG produced four different SCC estimates by using different discount rates. According to the IWG's 2010 Technical Support Document, the 3-percent discount rate estimate is considered the central estimate because it uses the central (i.e., middle) discount rate and is based on an average or mean, rather than worse-than-expected, climate outcome.); *See also supra* notes 3 and 5.

8 Jane A. Leggett. "Federal Citations to the Social Cost of Greenhouse Gases." Congressional Research Service (Mar. 21, 2017).

9 See AR5, *supra* note 8, at Topic 1: Observed Changes and their Causes.

10 See AR5, *supra* note 8, at Topic 2: Future Climate Changes, Risk and Impacts.

11 IPCC. *IPCC Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* (2018) [V. Masson-Delmotte, P. Zhai, H. O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, T. Waterfield (eds.)]. World Meteorological Organization, Geneva, Switzerland, 32 pp.

12 Leggett 2016, *supra* note 7.

13 DICE2013-R and FUND 3.9 have since become available.

14 Omitted Damages, *supra* note 2.

15 Omitted Damages, *supra* note 2, at 16; *see also* Yohe, G. W., & Tirpak, D. (2008). A research agenda to improve economic estimates of the benefits of climate change policies. Integrated Assessment, 8(1).

16 Revesz et al. 2014, *supra* note 4.

17 Omitted Damages, *supra* note 2.

18 Omitted Damages, *supra* note 2, at 17.

19 For a more detailed explanation, see Omitted Damages, *supra* note 2, at 42-43."

20 See Omitted Damages, *supra* note 2, at 43.

21 Omitted Damages, *supra* note 2.

22 Washington uses the 2.5% discount rate and California is exploring the use of the high impact estimate, which is taken from the 95th percentile of the central range. See CostofCarbon.org for more details on state use of the SCC.

23 Policy Integrity 2017, *supra* note 1.

24 Nat'l Acad. Sci., Engineering & Med., *Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide* 3 (2017), https://www.nap.edu/read/24651/chapter/1; Nat'l Acad. Sci., Engineering & Med., *Assessment of Approaches to Updating the Social Cost of Carbon: Phase 1 Report on a Near-Term Update* 1–2 (2016); https://www.nap.edu/read/21898/chapter/1.

25 See http://www.rff.org/research/collection/rffs-social-cost-carbon-initiative.

26 http://www.impactlab.org/research-area/social-cost/.

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